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AMPHORE -- A WORKBENCH FOR FILM DOCUMENTATION

Klaus Süllow

UNITED STATES PATENT AND TRADEMARK OFFICE
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AMPHORE -- A WORKBENCH FOR FILM DOCUMENTATION
[AMPHORE-Ein Arbeitsplatz zur Filmdokumentation]

AMPHORE – a movie documentation workbench

AMPHORE is a client server system for the documentation of moving image material. The server mainly is formed by a full text database with SGML capabilities while the clients are PC working places equipped with software for documentation and retrieval of movies and/or movie parts. In AMPHORE, the complete film material is provided in digital form and thus can be used for content-oriented documentation and retrieval in a convenient way. This enables the documentalist to build very detailed indexes allowing access by sequence or even by shot. The film descriptions are based upon a syntactical, thesaurus-controlled indexing which reflects the films' diverse action strings and levels.

1. Introduction

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Two trends seem to shape documentation work in the near future: the increasing automation of text indexing and the growing importance of nontextual information, particularly audio, images and moving images. The value-preserving and value-creating work of the documentarist will thus be aimed more at indexing nontextual material, which raises the issue of the documentary workbench of the future. Media archival work will have to satisfy new requirements as expressed particularly in the new services of archives that today have crystallized out at least to some extent.

• Similarly to that which has long been the case for text archives (online databases), media archives will also be searchable via data networks. The WorldWideWeb Internet service shows very clearly that such services are already coming into existence. Present network bandwidths permit the transmission of high-quality material only in exceptional cases, which is why for the near future such services will offer only "preview" quality, which is sufficient for sorting through material that has been discovered. Moreover, such a restriction of access to the original material may well be in the interest of the respective provider.

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* [Numbers in the margin indicate pagination of the foreign text.]

• For new productions (no matter of what type of media) it is economically and also often qualitatively advantageous to archivers and producers if more use can be made of archive holdings than previously. Such a demand increases the importance of content-oriented access to the holdings and additional typical production demands arise for research, such as the search for a film scene of a given length, camera setting, illumination, etc. Alongside the "classical" content-related and formal search criteria, therefore, new characteristics worthy of "documentation[1]" are arising and documenting them particularly requires direct access to the archive material. /68

Precisely in regard to the content-related indexing of film material, today's film archives fail to differing degrees to meet these coming requirements on media documentation. This documentary gap in the film archives can be crudely classified by the respective personnel situation:

• For archives with minimal personnel resources, content-related indexing takes second place to formal indexing. This is hardly likely to change in the near future, because not even a simple sorting of the material can be guaranteed in this case.

• In film archives with small holdings there are generally already attempts at content-related indexing, but almost always the entire film or piece must serve here as the documentary unit. New acquisitions are examined, but a more detailed documentation, down to the level of scenes or even cuts, cannot be achieved in the time available because of the technical resources.

• If there is content-related sequence indexing, this is done at a very high personnel cost, which in turn implies that only a few large institutions can afford this expense.

The logical goal must therefore be to use new technologies such that a high precision of documentation can be achieved with a lesser expense than previously,[2] a goal which has been envisioned in the AMPHORE project presented in the present work.

The AMPHORE (Audio-visual Media Platform for the Highlighting, Organization and Retrieval of Entities) project is based on an idea from C. Carlson [2], the implementation of which was started in fall 1994 on the basis of a cooperation between the IWF (Institute for Scientific Film) of Göttingen and the IPSI (Institute for Integrated Publication and Information Systems) of the GMD in Darmstadt. At the present time, a first prototype is available, already featuring the three central components of the overall system:

• a database for managing film documentation

• a (software) system for the documentary acquisition of films (see section 3) and

• a search system (see section 4).

While the database is a commercial SGML-capable document management system, the acquisition and search systems are developments of IPSI. Thereby it is possible to feed prior conceptual considerations (see section 2) directly into the software development.

2. Prior considerations and conception

In current research, there are several approaches that promise progress in film documentation. Here are only the most important ones:

1. The basis for any content-related documentation of films is a decomposition of the films into subsequences. The concept of sequence can hardly be defined exactly, but a decomposition on the basis of the cuts is certainly a good first approximation to the problem. Consequently, automatic cut recognition is a goal that many projects are pursuing (e.g., Zhang et al. 1995 [13]). While the automatic recognition of hard cuts is comparatively simple and can be considered largely solved, the distinction of soft cuts from rapid or complicated camera movements is much more complex. Even for this, however, reliable solutions in the next few years can be expected [13]. An initial classification of the discovered setting can be done by filtering out characteristics such as colors or certain regular shapes. Such "features" can then flow back into the cut recognition process (Hampapur et al. 1995 [6]).

2. While the approaches just mentioned forgo an analysis of the film content. There are already ambitious projects that intend to automate the content-based classification or indexing of image information as well, relying on image recognition methods. It has been seen, however, that such systems will be available in the near future only for precisely delimited "domains" of image or film information (maps, for instance), because they presume a specific knowledge base (Pentland et al., 1995 [8]), in which shapes or movements are available in abstract form. It is also scarcely conceivable that moods or associations that images convey and which are also "worthy of documentation" will ever be detectable in this manner.

3. More promising in the short to medium term is the attempt to use information accompanying the image information such as the audio narration (Gauch et al., 1994 [5]; Smith et al., 1995 [9]) or subtitles for automatic indexing. Of course, only one content aspect of many can be acquired in this way, but for an initial verification of the material in the archive this is certainly sufficient. Information obtained in this way can naturally also be further refined with automatically obtained "features" (Srihari, 1995 [10]). A deficit of this approach is that objects and actions that are only indirectly visible in the film can scarcely be detected in this manner because this accompanying information as a rule supplies more an interpretation than a description of the image content. Overcoming this deficit is a central concern of AMPHORE. /69

4. Because of the multiple levels of meaning in image material, no indexing can be complete, which is why browser tools for examining the archive are much more important for

image and film databases than for text databases. These tools offer various ways of moving from one object in the holdings to the next: by following explicitly placed reference (hyperlinks), by (possibly implicit) placement of database queries that lead from the present unit to units with similar content or by implicitly searching for visually similar images (which can be achieved, for instance, by the comparison of "features"). While such a tool is practical for an image database, an additional problem in the case of film databases is that a film sequence can scarcely be surveyed "with one look" and therefore a relatively large amount of film material cannot be searched rapidly without additional technical support. Alongside the traditional techniques of fast forward and reverse, a digitization of the film offers the possibility of automatically determining a still image representing the shot (Arman et al., 1994 [1]) and accessing it directly. Particularly attractive here is the attempt to generate a new artificial image from all the images of a shot that shows the entire space covered by the camera in a scene at a single glance (Teodosio/Bender, 1993 [12]).

5. Even if all the aforementioned approaches are developed to perfection, the documentation process will still not be fully automatable; in media documentation, moods and associations that are based on human life experience play a great part.[3] It is therefore obvious to provide targeted support for this work process—and that is a concern in AMPHORE. Thus, for instance, many institutions work in multiple phases: new acquisitions are covered only roughly in a first step, so as to have at least some verification, and only later is a more detailed content description undertaken. Depending on the estimated importance of the material, these later steps may also be omitted. An undesired effect brought about by manual indexing[4] is the inter-indexer effect, which is particularly strong in the case of film documentation (see below). In AMPHORE, there is an attempt to minimize this effect, which can occur even inside a film in case of sequence-precise documentation, by special support.

To bring it all down to a simple formulation, it is intended with AMPHORE, using hypermedia (= hypertext + multimedia) methods, that film sequences will be documented as precisely as possible and will become searchable. This implies in detail:

Film material, accompanying material and documentary information form a unit, i.e., they are to be linked together in terms of content and also technically. In AMPHORE, this is achieved by providing the entire film material in digital form. This is currently being done by JPEG compression (Motion JPEG); in the next stage, that will be replaced by the more suitable MPEG compression. The quality that is achieved is certainly far from the original quality in every case, but is completely sufficient for examining the content of the material.

Cross references between information components are supported implicitly and explicitly. "Implicitly" means in this case that similar sequences can be gathered together with the aid of suitable database queries. "Explicit" support is understood to mean links and references

that do not follow from the implicit linking or that are to be particularly emphasized. Thus, for instance, a text passage in the accompanying material can contain a link to an explanatory or associated film sequence. This link is processed in AMPHORE and can then be traced interactively (i.e., by clicking with the mouse).

A number of problems occur in relation to content-based sequence documentation. On the one hand, a dilemma known from image documentation also recurs in film documentation; the phrase "a picture says more than a thousand words" summarizes this complex of problems. There is an attempt in AMPHORE to meet this problem in two ways. First, it is attempted by means of a rule corpus to separate directly perceivable "phenomena" from interpretive statements on the material (this corresponds roughly to the separation between "ofness" and "aboutness"); second, documentation is strictly controlled by thesauri. It is evident that the problem is not eliminated by these conventional means, but is at best ameliorated. Thus, a case is illustrated in [3] in which a group of 18 test subjects (not only documentarists) only twelve persons used the term "Eiffel Tower" for a picture that shows nothing but the Eiffel Tower and the Seine (used nine times) in the foreground.

If, as in AMPHORE, film sequences are documented instead of individual images, then additional questions arise. Two items are worthy of particular mention. First the question arises as to who actually defines the scope of a film sequence, and thus that of a documentary unit. In AMPHORE, this is the documentarist himself, which is why software tools are made available to /70
determine or change sequence boundaries. The fact that the indexer established the units of indexing, in contrast to image documentation, naturally amplifies the inter-indexer effect considerably. That results in new requirements on a rule corpus.

A second difference between film and image documentation is that for film indexing the action moves more into the foreground with respect to the objects represented. This can be met by substantivizing verbs ("seizure," "fox," "rabbit"), which does not always appear precise enough. From the description ("bird flight," "magpie," "crow"), for instance, it is ultimately unclear which bird is flying here, the magpie, the crow, both or some other, unspecified bird. Consequently indexing in AMPHORE is syntactic, with a subject field, which must be filled out, an optional verb field and up to four optional object fields.[5] Subject and object fields are controlled by a shared "noun" thesaurus and the verb field by its own "verb" thesaurus.

At least one such "SPO" construct must be assigned for sequences, which means that a single subject is sufficient for description, since predicate and objects are optional. As a rule it will usually be desired to describe the material more precisely, which is why it is also possible to assign several constructs to the same film sequence. In this case, however, the order of the constructs reflects the weight of the underlying statement or action. Thus, the first construct is supposed to describe he central action of the sequence. With the aid of the formalism, the above

descriptions become ("fox," "seize," "rabbit") and ("magpie," "fly") alongside ("crow," "fly"), which makes it clear that both birds fly in the scene, but the flight of the magpie is more visually prominent.

In searching for film sequences in AMPHORE, a search via this syntactic indexing frequently supplies results, but by no means always sufficiently accurate ones. For this reason, all the other information belonging to the film in AMPHORE must also be present and searchable. In detail, these are:

- Formal data on the film in consideration such as director, title, production site(s), production year(s) and also a brief note on the content (frequently present).
- Accompanying information such as script, commentaries, scientific monographs (especially for scientific films). etc.
- Voice-overs, dialog, if available as text.
- Technical information such as the length of the individual sequences, their quality (e.g., black-and-white or color shooting) or cinematographic features (night shot, close-up, slow-motion/time lapse, etc.).
- The film material itself in digital form and
- the digitized audio material, if available separately from the image material.

If all these information components are put together, a quite complexly structured mixture of descriptors, freely composed texts, numerical and multimedia data results. A suitable model is required to be able to model this complex syntactically. For a number of reasons, SGML (Structured Generalized Markup Language) was chosen for AMPHORE:

- SGML is a widely accepted ISO standard (ISO 8879), expressed particularly in the fact that recently a considerable supply of software supporting SGML has been developed for the market.
- In particular, document management systems that explicitly support SGML have also been available for two or three years. Here it must be noted critically, however, that products are generally still battling with "infantile diseases," which have a negative effect on their stability and performance.
- The HTML format (Hypertext Markup Language) which is widely used on the Internet conforms to SGML, which means that a document management system based on SGML can also be used, at least in parts, for management of HTML documents.

For any use of SGML, the development of a DTD (Document Type Definition), or the selection of an already existing DTD, in which the concrete document structure is established, is fundamental. In the case of AMPHORE, a new development was inevitable. The AMPHORE DTD specifies that, for every film, a document is created that consists of one mandatory and four optional parts, namely:

• the DOKUMENT element: here the "filmographic" information is contained, i.e., author, title, etc. This part serves for verification of the entire film in the database and is therefore the only mandatory part of the AMPHORE document.

• the FILMDAT element: it contains a link to the file with the film data. The multimedia information is thus not stored directly in the database; instead, links to this information are managed. As long as the consistency of these links is guaranteed, no technical or methodological drawback results.

• the AUDITEXT element: it contains the dialog or narration of the film, if this information is available in text form. This element is downwards-compatible with HTML; i.e., it can be displayed without conversion in HTML browsers like Netscape or Mosaic. /71

• the BEGLEIT element: it contains the accompanying information as outlined above and/or links to it. This part is also downwards-compatible with HTML.

• the SEQUENZ element: it contains arbitrarily many elements of types SEQ or FRAME, which describe individual images of the film by means of the above-mentioned SPO constructs, by free text downwards-compatible with HTML and by technical data serving on the one hand to control the presentation of the films and on the other for searching.

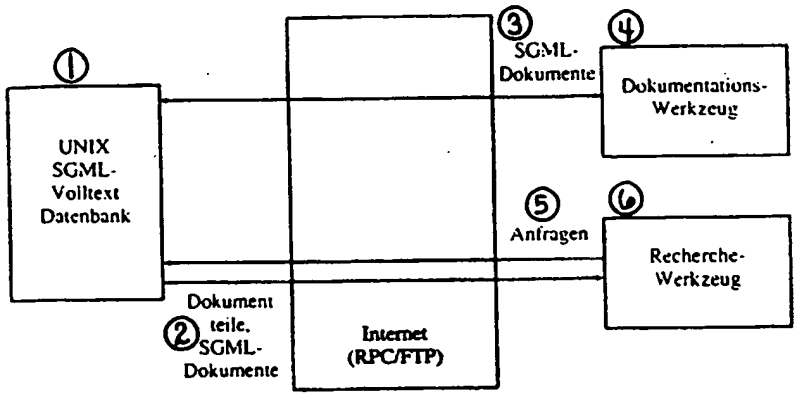

Figure 1: Client-server architecture of the AMPHORE system

Key:
1 UNIX SCML full text database
2 Document parts, SGML documents
3 SGML documents
4 Documentation tool
5 Queries
6 Search tool

AMPHORE is conceived as a multiseat system with client-server architecture. Situated in the center as the server is a UNIX database computer, which is accessed by PC workstations via Internet protocols (Remote Procedure Call RPC and File Transfer Protocol FTP). Documentation and Search tools can be called as needed at the PCs. Cf. Figure 1.

A technical problem of central importance is the digital storage of the films. Modern-day databases do permit the definition of correspondingly large objects (so-called BLOBs - Binary Large Objects), but this approach is ruled out [text possibly omitted from original] because the database server cannot guarantee that the client will be supplied with a continuous data stream, which it needs to play back the film "cleanly," i.e., without hesitation. An alternative would be to load the film data completely into the client computer before playback, which would in turn result in this loading time being longer than the actual film; this is an approach that is common in the WorldWideWeb, but is obviously unsuited to "interactive" film documentation.

In AMPHORE it is therefore assumed that the film data of a film are represented in a file of their own, while only the name of this file is managed in the database. The format in which this data exists and the technology with which the files are accessed are also not further specified in AMPHORE. Thereby the system is open to various solutions regarding the costs of the infrastructure, the scope of the film material in terms of time and its quality. An economical solution might look like this: all films are present on CD-ROM (a CD-ROM holds roughly an hour of film including stereo audio, assuming the customary MPEG-1 format) and this number of CDs are available at the documentarist's workstation. Inserting the respective CD in [text missing in original] ... For smaller archives with up to 1,000 hours of material this approach is well manageable and often probably the only realistic one for reasons of cost.

A more expensive solution, which can also gradually emerge from the previously sketched simple solution, is to manage the optical data media in jukeboxes (such media need necessarily be the CDs customary today; new "multimedia CDs" with ten to twenty times more capacity will appear on the market before the end of the millennium). The selection of the appropriate data carrier would then take place automatically; a problem not to be underestimated here is the necessity of transferring the data from the jukebox to the workstation. For this, a sufficiently fast network, another investment in some circumstances, is necessary.

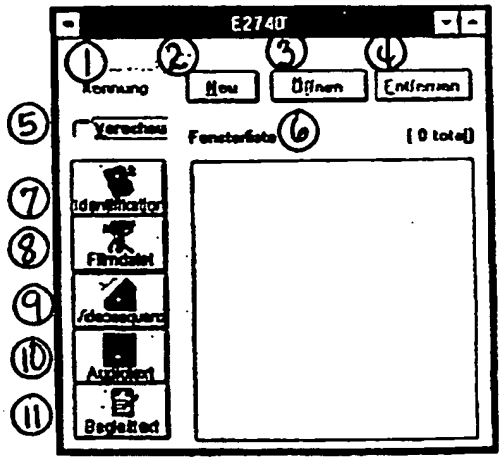

Figure 2: Overview window for calling the five subeditors for editing a ... [text omitted from original].

Key:
1 Name
2 New
3 Open
4 Remove
5 Preview
6 Window list
7 Identification
8 Film file
9 Video sequence
10 Audio text
11 Accompanying text

3. The documentation tool

Viewed technically, the AMPHORE documentation tool is an editor for editing SGML documents that match the AMPHORE DTD. If such a document is loaded, then this is represented by a menu (cf. Figure 2) that permits the editing of the five aforementioned document parts.[6]

Accordingly, there are five subeditors that can be called up via the menu items. As an /72
example, Figure 3 shows the subeditor for the DOKUMENT element. Since the use of these subeditors can bring about a number of open windows and, moreover, several documents can be edited simultaneously, confusing situations can easily arise, which is countered in AMPHORE by two means (see Figure 4).

On the one hand, comfort functions are provided that make it possible to close all or certain subeditors, to iconify them or to bring them to the front. On the other hand, subeditors that belong to the same document all have the same color. Thus, up to six documents are

differently colored, the colors being chosen such that, from the perspective of color theory, maximum contrasts result. Tests have shown that even users who are "poor with colors" manage these well.

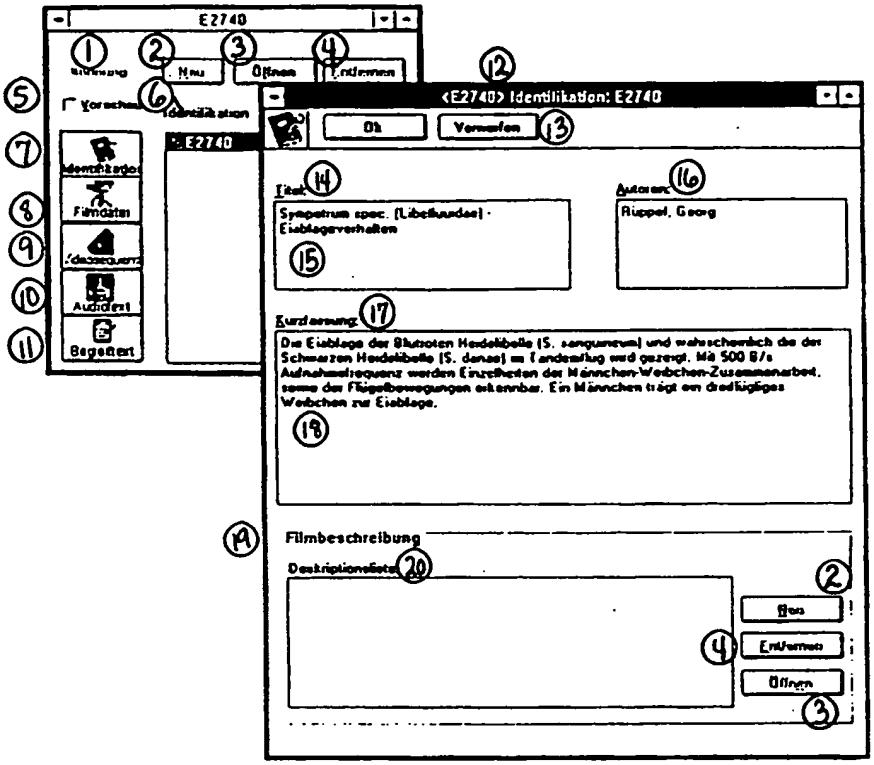

Figure 3: AMPHORE form for acquiring the general film-describing data

Key:
1 Name
2 New
3 Open
4 Remove
5 Preview
6 Window list
7 Identification
8 Film file
9 Video sequence
10 Audio text
11 Accompanying text
12 Identification
13 Discard
14 Title
15 Sympetrium spec. (Libelluridae) Egg-laying behavior
16 Author

17 Summary

18 The egg-laying of the muddy darters dragonfly (S. sanguineum) and probably that of the black meadow hawk dragonfly (S. danae) in tandem flight is shown. At a photographing frequency of 500 fps, details of the male-female interaction as well as those of the wing movements, become recognizable. A male carries a three-winged female to lay eggs.

19 Film description

20 Description list

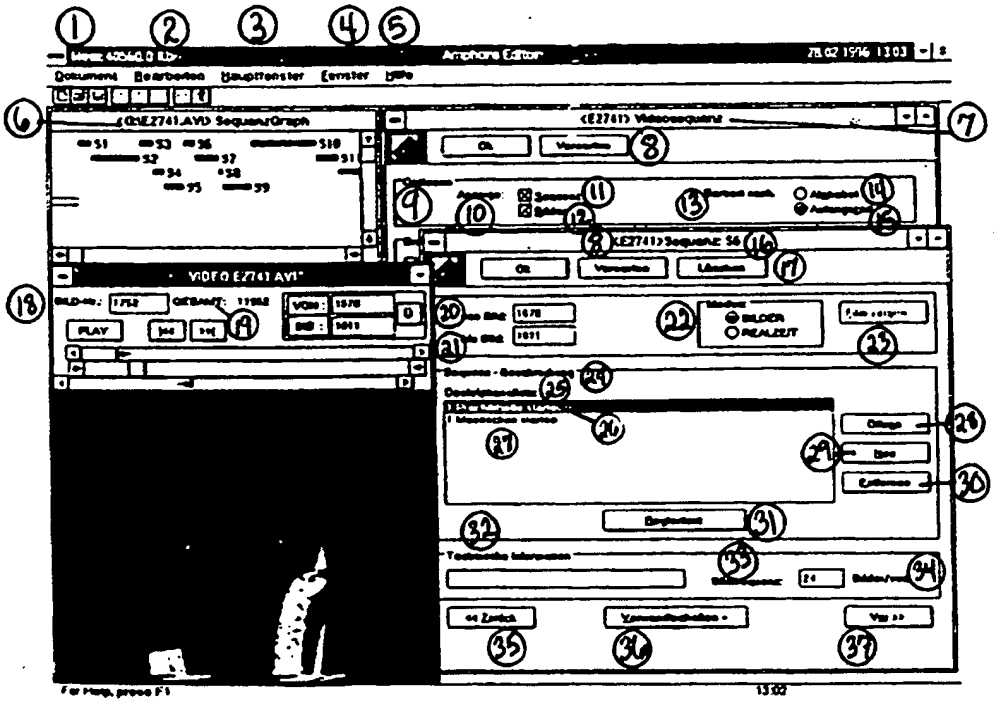

Figure 4: Working situation during documentation with AMPHORE

Key:
1 Document
2 Edit
3 Main window
4 Windows
5 Help
6 Sequence graph
7 Video sequence
8 Discard
9 Options
10 Display
11 Sequence
12 Frames
13 Sorted by
14 Alphabet
15 Starting time

16 Sequence
17 Delete
18 Frame number
19 Total
20 from frame
21 to frame
22 Modes
Frames
Real-time
23 [illegible]
24 Sequence description
25 Description list
26 [illegible] starts
27 Male starts
28 Open
29 New
30 Remove
31 accompanying text
32 Technical information
33 Frame rate
34 Frames per sec
35 Back
36 [illegible]
37 Forwards

4. The Search Tool

The basic idea of the AMPHORE search system[7] is to make use of all, or as closely as possible to all, of the information available in AMPHORE for the search. This is achieved by offering the user four different search forms that can be combined in arbitrary numbers with the operators "AND" and "OR." In detail, these are:

• The DESCRIPTORS form (Figure 5), which permits the search via SPO constructs. The individual fields are automatically checked for thesaurus conformity before the start of the search, i.e., "wrong" queries are not possible. With the aid of a thesaurus browser (call for the individual fields via the respective "TH" switch) the query fields can also be filled in by menu control, which is of use in practice particularly to the occasional user of the system. /73

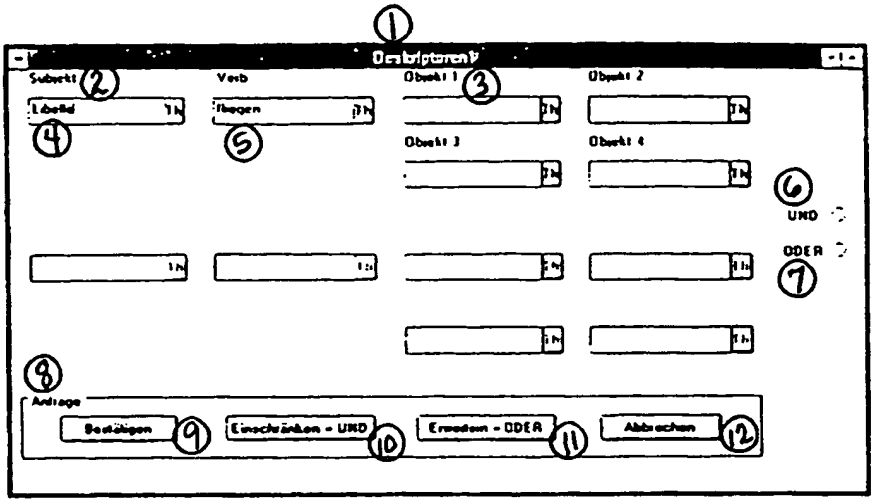

Figure 5: Form for search with descriptors or subject-predicate-object constructs

Key:
1 Descriptors
2 Subject
3 Object ___
4 Dragonfly
5 to fly
6 And
7 Or
8 Query
9 Confirm
10 Restrict = AND
11 Broaden = OR
12 Cancel

• The FULL TEXT form (Figure 6). All free text parts of the documents are indexed taking into account a stop word list and are offered as a menu (to the left in the figure). The full text search can relate to the entire document or only to the checked-off parts (to the right in the figure).

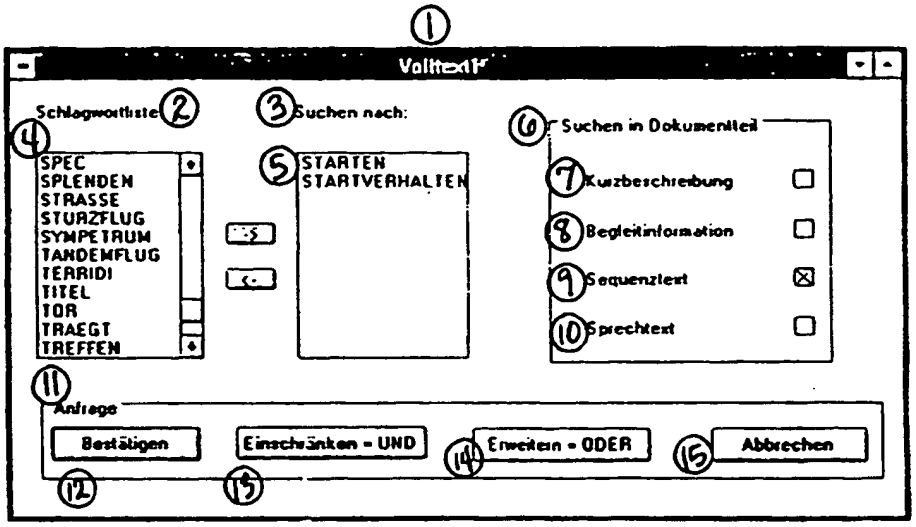

Figure 6: Form for full text search in AMPHORE

Key:
1 Full text
2 Keyword list
3 Search for
4 Spec - splenden - street - nosedive - sympetrum - tandem flight - terridi - title - gate - carries - to meet
5 Start - starting behavior
6 Search in document part
7 Brief description
8 Accompanying information
9 Sequence text
10 Spoken text
11 Query
12 Confirm
13 Restrict = AND
14 Broaden = OR
15 Cancel

• The DOCUMENT form (Figure 7) is a traditional search form for the film database. This is how films of a given director or with a given title, etc. are found.

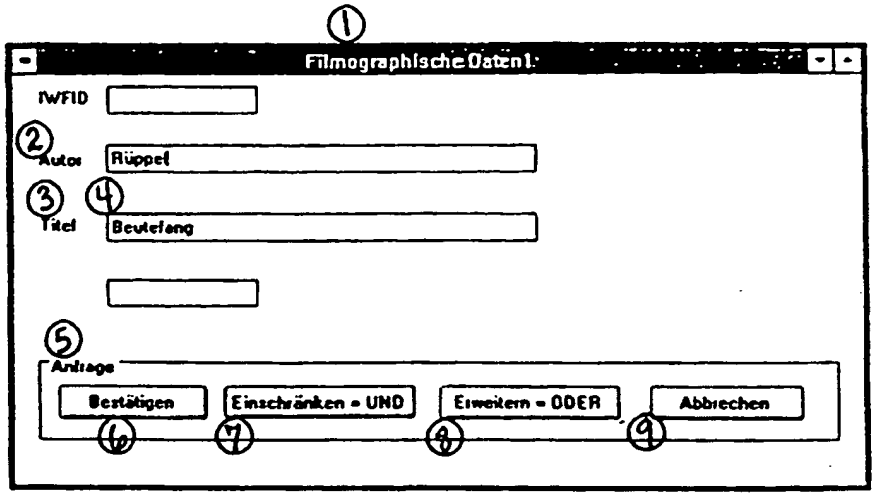

Figure 7: Form for searching for films by means of formal film database [illegible]

Key:
1 Filmographic data
2 Author
3 Title
4 Catching prey
5 Query
6 Confirm
7 Restrict = AND
8 Broaden = OR
9 Cancel

• The TECHNIQUE form (Figure 8) ought to be of particular interest if the search is carried out for production support. With it, one can find, for instance, sequences of a given duration or with given characteristics (e.g., black-and-white shots or slow-motion sequences) that are not content-specific. The typical numerical data here need not be exact, but can also be listed as an interval, e.g., "120 sec ± 30 sec" for sequence length.

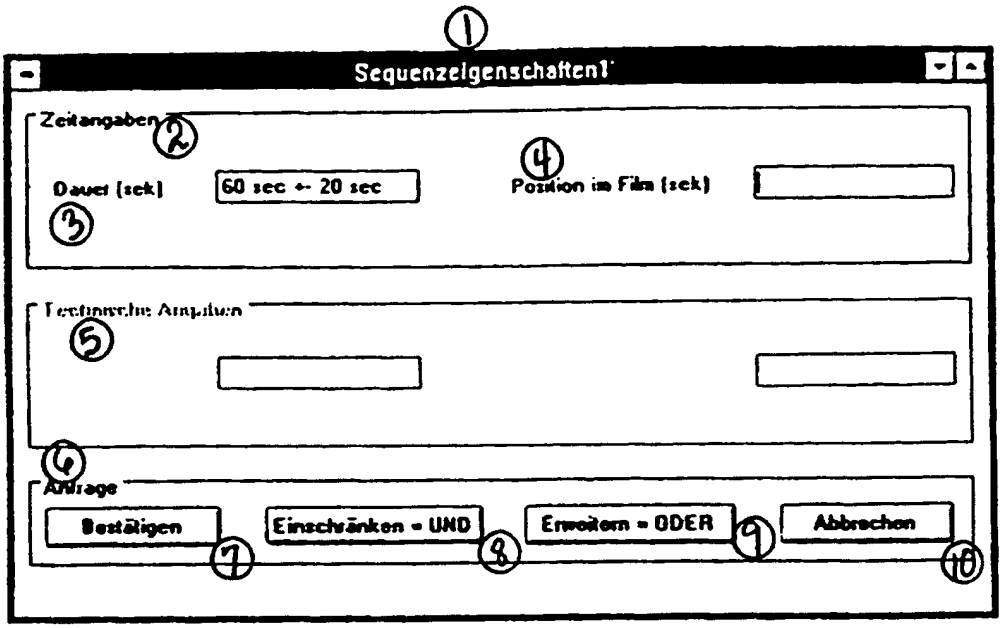

Figure 8: Form for searching for film sequences based on technical features

Key:
1 Sequence characteristics
2 Time data
3 Duration (sec)
4 Position in the film (sec)
5 Technical data
6 Query
7 Confirm
8 Restrict = AND
9 Broaden = OR
10 Cancel

5. Outlook

AMPHORE can be viewed as a "frame" system that offers space for many expansions and applications. Consider merely the fact that audio and (still) images are merely special cases of sound film from the technical perspective and therefore can be stored and managed no differently than other films. Of course, experiences with such integrated media archives show that descriptions independent of information type must be more precisely separated from content for this purpose than has previously been the case with the AMPHORE DTD [11].

In regard to technologies of image processing, such as the recognition of cuts, much less objects, they can be used to support the documentation work and thus considerably increase work efficiency. It should also be noted that these techniques do not constitute a restriction of

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"documentary freedom." Background knowledge and experience of the world will continue to make people indispensable in media documentation for the foreseeable future.

Film documentation; SGML application; system; searching

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Notes

[1] These may well be viewed as "formal" because they are not directly content-related. One should consider, however, that the content structure is reflected in these data.

[2] It should not go unmentioned that such innovations will in the medium term reduce personnel expenses in those achieves that already index to the sequence-level. It is equally clear that this effect is compensated for in the smaller achieves by the additional value creation that is then possible.

[3] And acquire even more significance with the increasing automation of work and everyday life.

[4] And, incidentally, by automatic indexing as well, if different systems are involved.

[5] This approach originates with C. Carlson [2].

[6] An idea from A. Müller, whose paper [7] described the technical details of the AMPHORE "editor."

[7] Technical details are found in [4].